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## SCIENTIFIC RESEARCH AND INDUSTRIAL DEVELOPMENT

THERE are various ways in which science can be brought to influence industrial development—by direct contact between private firms and university scientists, by the work in Government-sponsored laboratories or by the research associations of industrial groups themselves. While it is desirable that scientists in the universities should act as advisers to industrial concerns, the universities should mainly be concerned with fundamental research. Similarly, one of the functions of the Government laboratories would be to explore the possibilities of industrial application of our natural products, while the further adaptation of these processes to large scale manufacture and problems arising from them should properly be studied in the research laboratories of industrial firms themselves.

Unfortunately, there seems to be little recognition of the necessity for research in many of the industrial concerns in our country to-day. Apparently, this complacency on the part of our industrialists is not entirely absent even in a much more advanced country like Great Britain. In his book entitled "The Neglect of

Science",\* Professor F. E. Simon of the University of Oxford, draws attention to the backwardness of British Industry in this respect compared to other countries like Switzerland and the United States of America.

Analysing the causes of Britain's industrial backwardness, Professor Simon traces it rightly to the lack of higher technological education of the level attained for instance in the Technische Hochschule at Zurich or the Institutes of Technology at Massachusetts or California. Emphasizing the indispensable rôle played by engineers—scientists as liaison between the fields of fundamental research and industry, he deplores the fact that the technical education of creative engineers and applied scientists is at present mainly left to the rather small engineering departments attached to the universities. "While these may be suitable for the education of technicians—though even in this respect they do not compare too favourably with their opposite numbers abroad—they are wholly unsuitable for

\* *The Neglect of Science—Essays Addressed to Laymen* by F. E. Simon, F. R. S., Basil Blackwell, Oxford, 1951.

educating engineers of the type with which we are concerned here. Hardly any of these colleges carry out any research worth the name, and this alone is enough to show that they cannot have people on their teaching staff really able to supply proper training in the subjects." This may be compared with the original statement regarding the four years' under-graduate course in science at the California Institute of Technology, which says: "Its purpose will be to provide a college education which, when followed by one or more years of graduate study, will best train the creative type of scientist or engineer so urgently needed in our educational, Governmental and industrial development.... In all the departments of the Institute, research is strongly emphasized, not only because of the importance of contributing to the advancement of science, but because research work adds vitality to the educational work of the Institute and develops originality and creativeness in its students".

In the light of the above, it is to be earnestly hoped that at least the newly established Institutes of Technology would strive to maintain such a standard of instruction and devote themselves to the training of engineer-scientists, who would play a notable part in the industrial progress of our country. However, one has to realize, as Prof. Simon says, that "it is not enough" to create such an organization; it must also have the full support of industry. Unfortunately, one gets the impression that many industrialists are not fully awake to this point. This is perhaps due to the fact that on the boards of our companies we have no proper representation of scientists or engineers".

Besides taking early steps to reform the technological education in this country on the lines indicated above, it is eminently desirable, if only as an act of enlightened self-interest of long range utility, that our industrialists should create endowments of the nature of the Rock-

feller Foundation and the Carnegie Institution, where fundamental research can be carried out without much disturbance. In the words of Prof. Simon, "Since people and Government are very often interested only in the fairly near future, the question of giving adequate support to fundamental research has hardly ever received the attention it deserves, and the general public in particular, knows little about what is to be done".

We believe that there is a great opportunity here for private enterprise, which should not be lost sight of. This is especially to be desired because official bodies, however broad-minded, have a tendency to lay the stress on particular fields of research, with consequent detriment to all the other branches in which scientists may specially be interested. Also, there can be no greater stultifying influence upon pure research than the feeling that results are awaited by someone. It is easy enough to get plenty of results by choosing a suitable field—but this is not how progress is made in science.

Finally, some people may ask why, when fundamental research published in one country benefits industrial development all over the world, is it necessary to have fundamental research in all the countries? Why not leave it—especially in times of financial stress—to the richer countries?

Such a negative attitude, it is needless to point out, would be disastrous for any country which adopted it. Quite apart from the question of providing satisfactory education for the practical or applied scientists, we must remember that the scientific community is a living one with an equilibrium between different types of people and different types of research. It is, therefore, impossible to neglect the fundamental aspects of research without seriously affecting the onward march of science, on which industrial development ultimately depends.

#### NOBEL PRIZE FOR MEDICINE—1951

**D**R. MAX THEILER, who has been awarded the Nobel Prize for Medicine this year, was born in S. Africa in 1899. After his training in the London School of Tropical Medicine he worked at Harvard, in the Department of Tropical Medicine. It was there that he developed his work on the susceptibility of white mice to intra-cerebral inoculation of

yellow fever virus. Later, Dr. Theiler moved to the International Division of the Rockefeller Foundation, New York, where he made the discovery of the innocuous nature of 17D sub-culture of the Asibi strain of yellow fever. This strain is widely used for immunizing against yellow fever.

# THE PHYSICS AND CHEMISTRY OF LUBRICATION\*

THE basic laws of friction have been known for a long time. In fact, Leonardo da Vinci (1452-1519) wrote: "Friction produces double the amount of effort, if the weight be doubled" and "The friction made by the same weight will be of equal resistance at the beginning of the movement, although the contact may be of different breadths and lengths". The laws were rediscovered by the French Engineer, Amon- tons, in 1699, and are generally known by his name.

Leonardo da Vinci also made a number of observations on friction and some of them are significant in the light of the latest studies. He wrote, "All things and everything whatsoever, however thin it be, which is interposed in the middle between objects that rub together, lighten the difficulty of this friction". As will be seen from what follows, this seems indeed to be exactly true.

No further progress appears to have been made in understanding the fundamentals of lubrication until the 1880's, when Osborne Reynolds in England published a paper<sup>1</sup> explaining the load-bearing capacity of a fluid film on the basis of hydrodynamic theory. At about the same time, Petroff<sup>2</sup> in Russia was able to calculate the friction in a fluid-lubricated bearing. Reynolds enunciated the principle that the load-bearing capacity of a fluid film was due to the pressures developed when the lubricant was drawn through a constriction, or a convergent wedge-shaped space, under the action of viscous forces and that wherever the geometry of the bearing permitted the formation of such a wedge, hydrodynamic forces would appear.

Most of the later work in this field of "hydrodynamic lubrication", i.e., where a film of lubricant occurs between the two rubbing surfaces, stems from this fundamental paper of Reynolds. The journal bearing is a typical, and perhaps the most widely used, example in which

Reynolds' theory is applicable. Numerous improvements in the theory have been made with regard to side leakage, film rupture (cavitation), effects of lubricant inertia, thermal expansion of lubricant, etc. There are, of course, some problems still to be cleared up, e.g., the observation that the parallel-sided thrust bearing can carry a moderate load hydrodynamically, of which no convincing theory has been found, even of a qualitative kind,<sup>3</sup> but by and large the main theoretical aspects of hydrodynamic lubrication are well understood. The survey of Christopher- son in I and of Burwell in II give a fairly comprehensive account of this field.

Hydrodynamic or thick film lubrication occurs for the general run of sliding contacts, and in this the most important property of the lubricant is its viscosity, allowing fluid films to be built up and the solid surfaces to be floated apart. The friction is due to shear of the fluid layer and the coefficients of friction are generally low (0.01 or less). The designer's aim should therefore be to ensure that such a fluid film is obtained, because the friction is then low and ideally there is no wear. In practice, this is not always possible. Even in those cases where fluid films are easily formed, like journal bearings, solid to solid contact occurs on starting. In other cases, the form of the surface makes it difficult to establish a fluid film, e.g., the opposite curvature of gear teeth surfaces. Further, in the fluid-lubricated mechanism, it is naturally the aim to increase the load as much as possible; the fluid film then becomes thin and the possibility of solid surface contact is increased. A study of lubrication under other than hydrodynamic conditions is therefore highly necessary.

When a solid surface rubs another and there is no fluid-film to take the load, the regime is called "boundary lubrication". Under these conditions, it is the chemical nature of the lubricant and the surfaces which are significant. In between this and hydrodynamic lubrication, there is a field known as "thin film lubrication", where the load is partially borne by the fluid. This field is comparatively little understood; Blok has given an excellent review of its fundamental mechanical aspects in II.

Many remarkable results have been obtained in recent years with regard to friction in solid to solid contacts. Metals cleaned in the ordinary way have a coefficient of friction  $\mu$  of 0.5-1, but if they are degassed in high vacuum,

\* I. *Physics of Lubrication*, A Symposium held by the British Rheologists' Club and the Institute of Physics, in June-July 1950; *British Journal of Applied Physics*, Supplement No. 1, 1951, issued by the Institute of Physics, 47, Belgrave Square, London, S. W. 1, p. 90. Price 15 sh.

II. *The Fundamental Aspects of Lubrication*, Report of a Conference on the subject, held by the New York Academy of Sciences, in March 1950. *Annals of the New York Acad. Sci.*, 1951, **53**, 753-994. Price \$4.00. These will be referred to as I and II respectively.

the value rises to 6 or more and complete seizure occurs on contact with most metals.<sup>4</sup> Even a trace of oxygen or water vapour prevents seizure and the friction is appreciably reduced, obviously due to the formation of surface films. Different gases and vapours have varying effects in reducing friction. Thus, with iron, oxygen and caproic acid vapour reduce  $\mu$  to about 1, while chlorine and hydrogen sulphide lead to values of the order of 0.5. Such effects are found even with diamond,  $\mu$  being 0.05 for a surface cleaned in the ordinary way, while it rises to 0.4, if cleaned in vacuum. Thus, surface layers play an important part both in reducing friction and in preventing seizure. Herein lies the importance of studying the chemistry of the lubricant and its relation to the formation of surface layers. X-ray and electron diffraction methods have been used in such studies and Brill gives a review of these in II. Finch provides a short, but interesting, summary of the results regarding the structure of boundary lubricant films in I. A number of papers, both in I and II, deal with surface chemical phenomena and on the effect of various reagents on boundary lubrication. Long chain compounds, soaps, acids and esters have been tried and most of them are useful boundary lubricants. An interesting observation in this connection<sup>5</sup> is that when the lubricant melts, it becomes much less efficient and also there is considerably more surface damage. This is directly related to the observation of Zisman and others<sup>6</sup> that monolayers of fatty acids on platinum occur only up to temperatures slightly above the melting point. Electron diffraction study<sup>7</sup> shows that good boundary lubrication occurs only when there is a closely packed solid film of oriented molecules on the surface, and above the melting point, the order is destroyed, leading to a reduction in the lubricating properties. Radioactive tracers have also been used to determine whether chemical action occurs between lubricant and the metal surface or not.<sup>8</sup>

For some applications, solid materials are employed as lubricants. Graphite is commonly used and its lubricating effect has been attributed to its plate-like cleavage. In I, Barwell and Milne report studies on lubrication with various powders like talc, mica, paraffin, etc. Talc, although one of the softest mineral known, has no lubricating effect at all. Micaceous minerals too are inefficient, thus throwing doubt on the view that a laminar structure necessarily endows a substance with lubricating properties. Incidentally, Savage<sup>9</sup> finds that the friction of graphite in vacuum is high, but lubrication

is effected instantly by any one of a number of vapours present even at low pressures.

Wear is another aspect of the rubbing of solids equally important as friction. Ideally, there should be no wear in hydrodynamic lubrication. But it is impossible to avoid the release of particles from surfaces by occasional contacts. The particles, together with airborne dust, will lead to a certain amount of wear. Laboratory studies on this subject have not led to much practical result, because actual conditions are so varied, and a clear understanding of the wear process has not yet been obtained. Anti-wear additives, such as tricresyl phosphate and iron carbonyl, to the lubricant have been found to give good results.

It is possible to demarcate a region of boundary lubrication in which there is a high intensity of contact pressure and a high relative speed of sliding. This is variously called as "extreme pressure" or "extreme boundary" lubrication. The former term is a misnomer for it is the sliding condition which is particularly severe; such conditions occur with hypoid gears and with metal-cutting tools. It then becomes necessary to employ a lubricant which will react with one of the surfaces to form a low shear strength solid layer which can largely prevent welding and subsequent damage and wear. In the paper by Shaw in II, the results obtained with a large number of organic compound on aluminium are given, which show that disulphides, mercaptans and long chain esters are particularly efficient. So far as practical application goes, satisfactory commercial grades of lubricants are available. There is still much interest in the fundamental aspects of the way these materials function. A possible clue is given by Finch and Spurr in I. They suggest that since the sulphide or other layer formed by the chemical reaction between the lubricant and the metal is readily fusible, it prevents the softening of the metal and the consequent rupture of the protective oxide layer. Based on the same principles, chemical pre-treatment of surfaces and thin coatings of soft metal on hard substrates have been used to promote good boundary behaviour of rubbing surfaces.

There are a few articles in both the reports dealing with other related topics, e.g., a 35-page review on "Viscosity and Molecular Structure" by A. Bondi in II and studies on viscosity at high rates of shear in I.

It has indeed been a stimulating experience to study the two reports. The discussions therein show clearly that the subject of lubrication

which until recently was mere workshop practice has now moved out of the engineer's domain to take its place as a regular branch of physical chemistry. A study of its fundamental aspects by physicists and chemists applying all the modern techniques available to them would thus appear to be essential for further progress in

the design and maintenance of almost every type of machinery.

G. N. RAMACHANDRAN.

1. Reynolds, *Phil. Trans. Roy. Soc.*, 1886, 177 A, 137.
2. Petroff, *Eng. J. St. Petersburg*, 1883, 1, 71; 2, 228; 3, 377; 4, 535.
3. Christopherson, I, p. 1.
4. Bowden, 11, p. 805.
5. Shooter, I, p. 49.
6. Bigelow, Glass and Zisman, *J. Coll. Sci.*, 1947, 2, 563.
7. Menter, I, p. 52.
8. Moore, I, p. 54.
9. Savage, II, p. 862.

### ULTIMATE CONSTITUENTS OF MATTER \*

PROF. CARL D. ANDERSON, of the California Institute of Technology, has presented the accompanying table of elementary particles of matter as known in March, 1951. He points out that all the particles discovered since 1932 are unstable; after a short time, they either undergo spontaneous decay or are captured by atomic nuclei.

Dr. Robert Oppenheimer as saying in this connection:

"An elementary particle is one that is so simple that one has no understanding of it whatsoever."

Besides the fourteen listed by Prof. Anderson, a fifteenth particle is also expected, viz., the anti-proton, of negative charge but with

#### Elementary Particles of Matter and Some of Their Interactions

Particle	Mass in electron masses	Year discovered	Average lifetime against spontaneous decay	Products of spontaneous decay
Electron	.. 1	1896	Stable	..
Proton	.. 1845	1890-1900	Stable	..
Neutron	.. 1848	1932	About 20 min.	Proton and electron
Positron	.. 1	1932	Stable	..
Positive $\mu$ Meson	.. 210	1936	$2 \times 10^{-6}$ sec.	Electron and two neutrinos
Negative $\mu$ Meson	.. 210	1936	$2 \times 10^{-6}$ sec.	Electron and two neutrinos
Positive $\pi$ Meson	.. 276	1947	$10^{-8}$ sec.	$\mu$ meson and neutrinos
Negative $\pi$ Meson	.. 276	1947	$10^{-8}$ sec.	$\mu$ meson and neutrinos
Neutral $\pi$ Meson	.. 264	1950	Less than $10^{-13}$ sec.	Two photons
Positive V-Particle	.. Unknown	1947	Less than $10^{-9}$ sec.	Unknown
Negative V-Particle	.. Unknown	1947	Less than $10^{-9}$ sec.	Unknown
Neutral V-Particle	.. Unknown	1947	$10^{-10}$ sec.	Probably mesons and photons
Photon	.. 0	..	Stable	None
Neutrino	.. 0	..	Stable	None

The 'elementary' character of the particles is rather uncertain; for, according to modern physical theories, particles may exist in "virtual" states in which they may have observable effects while not existing actually as independent observable particles. Dr. Anderson quotes

the same mass as the proton. According to a recent report the track of such a negative proton has already been tentatively identified in a cosmic ray disintegration photograph by Dr. Robert B. Leighton at Pasadena.

\* By courtesy of the *American Scientist*.

### UTILISATION OF MONAZITE

IN the course of his address to the Research Club at the Harcourt Butter Technological Institute, Kanpur, Sir S. S. Bhatnagar, Secretary, Ministry of Natural Resources and Scientific Research, observed that examination of the monazite sand from Travancore was taken up by the Government of India after World War II, and that it was found to contain cerium, thorium, and 0.14% uranium. An agreement, he said, has now been reached with the Society of Rare Earths, Paris, for setting up a factory

in India, treating 1,500 tons per year. There is already at present a pilot plant of 250 to 500 tons capacity, fetching about Rs. 15 lacs per year. In the course of a few months the factory will start functioning with full capacity. As cerium with small amounts of zirconium and magnesium has recently found use in the conversion of cast iron into steel, it is expected that when it is produced here, there is bound to be a great demand for it at very high prices.



## LETTERS TO THE EDITOR

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## RUSSEL EFFECT IN INDIAN TIMBER WOODS

In a previous note in this journal,<sup>1</sup> the author reported results of investigations made for the first time on the activity of Indian woods on photographic emulsions (Russel Effect). The present note deals with a quantitative study of the Russel Effect in ten representative specimens of South Indian woods: (1) *Pæciloneuron indicum*, (2) *Kigelia pinnata*, (3) *Mesua ferrea*, (4) *Acrocarpus fraxinifolius*, (5) *Butea frondosa*, (6) *Erythrina indica*, (7) *Holigarna Arnottiana*, (8) *Lagerstromia lanceolata*, (9) *Tectona grandis*, (10) *Dalbergia paniculata*.

The specimens under investigation were in the form of rectangular blocks ( $1\frac{3}{4} \times 1 \times \frac{1}{2}$ ") their broad surfaces being planed and smoothed. The woods were irradiated by sunlight for

10 minutes and activated thereby. They were then placed in contact with the sensitized surface of the photographic plate (Ilford Special Rapid). An exposure of 48 hours was given

TABLE I

Serial No.	Name of the wood	Transmittancy %	Density
1	<i>Pæciloneuron indicum</i>	10.3	0.985
2	<i>Kigelia pinnata</i>	20.7	0.684
3	<i>Mesua ferrea</i>	27.6	0.560
4	<i>Acrocarpus fraxinifolius</i>	30.0	0.523
5	<i>Butea frondosa</i>	31.0	0.508
6	<i>Erythrina indica</i>	31.0	0.508
7	<i>Holigarna Arnottiana</i>	31.0	0.508
8	<i>Lagerstromia lanceolata</i>	33.3	0.477
9	<i>Tectona grandis</i>	37.9	0.421
10	<i>Dalbergia paniculata</i>	58.6	0.232

in total darkness. The plates were developed for three minutes at 75° F., using ID-35 developer<sup>2</sup> and fixed in a hardening fixing bath<sup>3</sup> (G-303).

The density of the 'Russel images' were measured with a photo-electric cell.<sup>4</sup> The results are recorded in the Table.

From the table it is seen that the Russel Effect is most pronounced in the case of *Pocilion neuron indicum*. The weakest among the woods investigated is *Dalbergia paniculata*. The effect is found to be the same in the case of the three woods, *Butea frondosa*, *Erythrina indica* and *Holigarna Arnottiana*.

Further investigations on other species of woods as also on the heartwood and sapwood of woods are in progress. Details will be published elsewhere.

The author's thanks are due to the Forest Utilisation Officer, Madras, for procuring the specimens of wood.

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Chetput, Madras,  
September 1, 1951.

1. Narayanan Nambiyar, V P., *Curr. Sci.*, 1949, **18**, 284-86. 2. *Hford Photographic Formula*, p. 17. 3. *Gaert Photographic Formula*, p. 19. 4. *Gibb Optical Methods of Chemical Analysis*, 1942, p. 75.

### ELECTRONIC BANDS OF CERTAIN BENZENE DERIVATIVES

CONTINUING the previous work,<sup>1</sup> the absorption spectra of a number of disubstituted benzenes in the ultra-violet have been investigated under different pressure and temperature conditions. Results of *para*-, *ortho*-, and *meta*-substitutions by like and unlike radicals led to the determination of several fundamental vibrational frequencies. All the disubstituted benzenes investigated have allowed electronic transitions in this region. *Ortho* and *meta* derivatives gave spectra of a complicated appearance due to the large variety of vibrations that are possibly excited and resemble each other more than the *para* spectrum which is comparatively simple. The red shift of the 0,0 electronic transitions due to the substituents in these molecules is found to be in accordance with the additive rule. The progressive shift of the 0,0 band with the relative positions of the substituted radicals is found to be, in the case of the cresols, in the order *o*, *m*, *p*.

The upper state frequencies established in the

different substituted molecules are listed below:—

Molecule	Frequencies in cm. <sup>-1</sup>
<i>Para</i> -dibromobenzene ..	290, 470, 677, 1014, 1449
<i>Para</i> -dimethylbenzene ..	176, 229, 708, 771, 800, 1184
<i>Para</i> -cresol ..	415, 553, 778, 805, 1192, 2078
<i>Ortho</i> -cresol ..	298, 379, 483, 534, 701, 945, 958, 1132, 1212, 1317
<i>Meta</i> -cresol ..	183, 199, 696, 808, 950, 962, 1150, 1219, 1313
<i>Para</i> -dimethoxybenzene ..	501, 533, 892, 1297
<i>Ortho</i> -dimethoxybenzene ..	619, 918, 1021
<i>Meta</i> -dimethoxybenzene ..	590

The data compare well with the ground state frequencies obtained from Raman Effect.

A full account of the investigations will be published elsewhere.

Physics Department, K. SREERAMAMURTY,  
Andhra University, Waltair,  
September 6, 1951.

1. Sreeramamurty, *Ind. J. Phys.* 1950, **24**, 421. 2. — *Ibid.*, 1951, **25**, 122.

### ON THE TEMPERATURE OF MINIMUM COMPRESSIBILITY OF IONIC SOLUTIONS

PRECISION measurements of compressibility by Randall<sup>1</sup> have shown that the adiabatic compressibility of water exhibits a minimum value at 64° C. The effect of dissolved ions on this temperature of minimum compressibility may be expected to throw some light on the influence of ions on water structure. Accordingly, the temperature variation of the adiabatic compressibility has been investigated for two ionic solutions—potassium chloride (1N) and sodium carbonate (0.5N) in the temperature range 20° C. to 70° C.

Ultrasonic velocities have been measured by using the method of secondary interferences. A stationary wave-system was formed between a quartz transducer and a parallel reflector, in a glass cell containing the electrolyte. The Hiedemann pattern obtained by focussing on a plane containing the convergence lines was photographed, and the wave-length determined by measurement of the fringe width on a comparator. The cell containing the aqueous solution was maintained successively at different temperatures with the aid of an electric heater. Compressibilities are calculated from the measured acoustic velocities, and the known densities of the solutions. It is found that the compressibility minimum occurs in the tempera-

ture range 60° C. to 65° C. for the 1 N KCl solution and in the range 55° C. to 60° C. for the 0.5 N Na<sub>2</sub>CO<sub>3</sub> solution. Since the temperature of minimum compressibility for pure water is 64° C., the magnitude of the decrease in the ionic solutions investigated here is not more than 10° C.

It is interesting to consider the above result from the point of view of relaxational compressibility of water. The excess ultrasonic absorption in water, it is now generally accepted, is due to a structural relaxation on the lines explained by Hall.<sup>2</sup> The compressibility of water is thus composed of (a) an "instantaneous" compressibility, due to reduction of molecular volume, and (b) a relaxational compressibility due to some molecules of state 1 being forced to state 2 of closer packing. Now, the molecular or instantaneous compressibility increases with temperature as usual, but the structural compressibility decreases due to the progressive disappearance of hydrogen bonds above 0° C. These two opposing effects combine together to give a minimum value for the compressibility, the temperature at which this minimum occurs being determined by their relative magnitudes.

The existing data concerning the properties of ionic solutions suggest that the introduction of the ions produces a more co-ordinated arrangement of the water molecules. In particular, a correlation between various colligative properties and the change in height of the minor X-ray diffraction peak<sup>3,4</sup> (which is peculiarly structure sensitive), shows that the effect of ions is to carry the water structure farther to the right in the series of transformations (Bernal and Fowler<sup>5</sup>).

Tridymite-like—Quartz-like—Ammonia-like.

Hence the introduction of ions is expected to produce a "decrease" in the structural contribution to the compressibility and thus to lower the temperature at which the compressibility exhibits a minimum value.

I thank Professor R. S. Krishnan for guidance and valuable suggestions.  
Physics Dept., V. S. VENKATASUBRAMANIAN.  
Ind. Inst. of Science, Bangalore 3,  
September 28, 1951.

1. Randall, *Bur. Stand. J. Res.*, 1932, **8**, 79. 2. Hall, *Phys. Rev.*, 1948, **73**, 775. 3. Stewart, *J. Chem. Phys.*, 1943, **11**, 72. 4. Corey, *Phys. Rev.*, 1943, **64**, 350. 5. Bernal and Fowler, *J. Chem. Phys.*, 1933, **1**, 515.

#### THE SEISMIC SUSCEPTIBILITY OF THE AREA IN THE NEIGHBOURHOOD OF METTUR DAM, SALEM DISTRICT

The area in the neighbourhood of Mettur Dam has been known to be susceptible to minor

earthquake shocks at rare intervals. Such shocks were felt even before the construction of the Mettur Dam. During recent years, however, the shocks appear to have become more frequent.

A study of the topography and the geological features of the area in the neighbourhood of Mettur Dam reveals certain peculiarities which throw some light on the causes for the occurrence of these periodic disturbances.

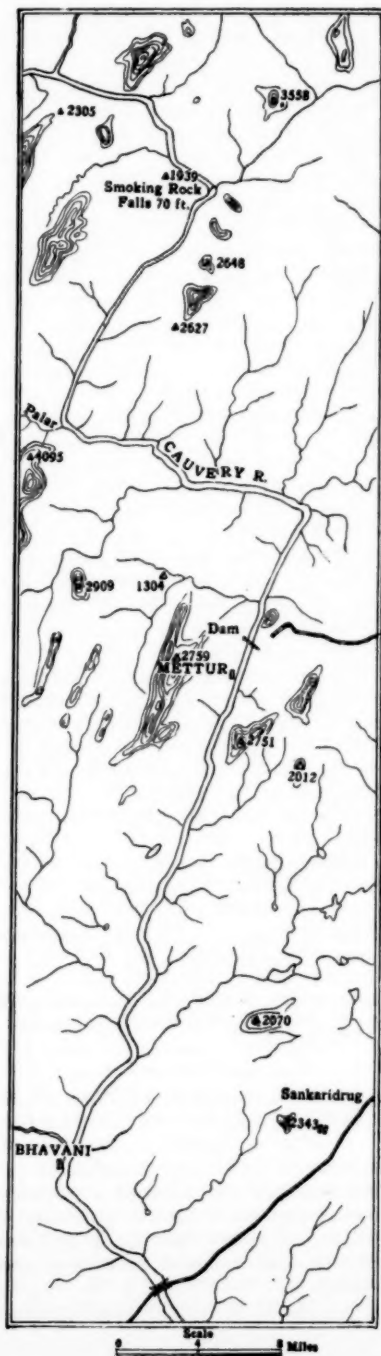
The sketch map given below indicates the characteristic flow of the river Cauvery above and below Mettur. Leaving the Mysore frontier the river keeps to an easterly course for about twenty miles. Near the Hogenkal or the Smoking Rock Falls the ground drops suddenly and the river plunges over a precipice 70 feet high. After this leap there is an abrupt change in the course to the SSW and from this point onwards the river flows in a narrow gorge for a distance of nearly 14 miles without deflection, suggestive of the flow being guided by a long line of fault. Meeting the river Palar coming from the west it captures its course and flows eastwards for about ten miles. At this point, a few miles above Mettur, there is again an abrupt change in the course, the river taking an acute bend to the SSW and flowing in a straight line for a distance of nearly 35 miles as far as Bhavani.

In a recent communication to *Current Science* Ghouse and myself<sup>1</sup> have pointed out how the straight course of the river Arkavati and its tributary twenty miles west of Bangalore is indicative of flow along fault planes. The course of the river Cauvery, here illustrated, is an even better example of river flow along fault planes. It may probably be argued that flow along tension joints parallel to strike and dip can adequately explain river flow in straight courses and that there is no necessity to invoke faulting. While such an explanation may be possible to account for the straight courses of streams and streamlets flowing over short distances it cannot be said to hold good in case of a major river like Cauvery with its large volume of water and enormous destructive power. Moreover, flow in straight courses extending for several miles cannot be explained in any other way except on the assumption that the flow is guided by a long narrow zone of weakness.

The area has not been geologically surveyed in detail and confirmatory evidence of faulting is lacking. Surface examination does not appear to have shown any signs of faulting as is evidenced by the reports of geologists on the dam site at Mettur. Excavations, however, re-



SKETCH MAP OF AREA NEAR METTUR  
DAM, SALEM DT.



vealed "a very deep and extensive fault from about L. S. 2300 as far as L. S. 2850 where the rock level again rose sharply".<sup>2</sup> This was called the "Deep Hole" and the excavation at this point had to be carried down to a depth of 75 feet below ground level over the entire width of the dam. Dr. West<sup>3</sup> who examined the cores obtained from this section, has stated that the rock which came in bits was almost white in colour, but that it was not certain whether it was a siliceous variety of the gneiss or only pegmatitic material. He has also observed that during the boring numerous sections of a very soft rock were encountered, so soft that no cores were obtained, and the drill suddenly descending several inches as each patch was reached. He was not clear as to what this was due to.

Mylonitic and trap-shotten structures are observed in outcrops in the bed of the river near Mettur. There are two east-west dolerite dykes which cross the road from Mettur to Bhavani. These dykes which cut the charnockites step near the river and are not traceable on the other bank which is composed of pink gneisses. Rao Bahadur M. Vinayaka Rao<sup>4</sup> who has examined the foundation excavations at Mettur also speaks of a dyke stopping dead at the toe end of the dam and getting much broken up.

These evidences would indicate the existence of a major line of fault which has guided the course of the river Cauvery. The identification of this weak zone would satisfactorily account for the periodic tremors felt over the area. It seems desirable to instal a seismograph at Mettur Dam to locate the centres of disturbance and also to find out whether there is any periodicity in these tremors and whether they bear any relation to the quantity of water stored in the reservoir.

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September 25, 1951.

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MECHANISM OF FLUORINE REMOVAL  
BY CALCIUM SALTS

Two theories have been put forth to explain the removal of fluorine from drinking water by tricalcium phosphate and bone salt. First one is the theory of anion exchange<sup>1</sup> and the second is of adsorption in terms of Freundlich adsorption isotherm.<sup>2</sup> In their present form, neither of these theories alone nor a combination of the two can satisfactorily explain the fluorine-removing capacity of calcium phosphate and bone salt.

Studies have been carried out, employing different calcium salts, to elucidate the point in question and the results obtained are summarised in this communication.

(1) When a solution of sodium fluoride is equilibrated with calcium phosphate, raw bone meal and purified bone meal, it is observed that at equilibrium (a) the clear filtrate in every case has the same sodium concentration as the original solution; (b) the filtrate is alkaline, contains phosphorus and small quantities of calcium; (c) the fluorine concentration of the filtrate is less than that of the original solution, indicating that fluorine is removed by these substances. When the logarithm of the quantity of fluorine removed per gram of the substance  $x/m$  is plotted against the logarithm of the concentration of fluorine remaining in the solution at equilibrium (C), a straight line relationship is obtained in each case, i.e.,  $\log x/m = \log K + 1/n \log C$  or  $x/m = KC^{1/n}$ . This indicates that the removal of fluorine by these substances is brought about by the mechanism of adsorption. As the original solution and the filtrate at equilibrium have the same sodium concentration and removal of fluorine in each case is followed by the production of phosphate and alkalinity in the filtrate, it is deduced and has also been proved that the adsorption of fluorine by these substances is an instance of ionic adsorption, involving the exchange of fluorine with hydroxide and phosphate in calcium phosphate, and with hydroxide, carbonate and phosphate in raw and purified bone meal.

(2) As a result of heating at about 500°C. for 15 to 30 minutes, raw bone meal, purified bone meal and calcium phosphate show a decrease in their adsorptive capacity for fluorine. Except for loss in weight due to loss of moisture in calcium phosphate and due to loss of moisture and organic matter in raw and purified bone meal, there is no loss of any mineral constituent of these substances on heating. From this, it has been inferred that the reduction in the adsorptive capacity of the compounds is not due to loss in phosphorus complement of the compounds but is due to the change in their essential structure. The adsorption of fluorine by the heated compounds also is ionic and involves the exchange of fluorine with hydroxide and phosphate in calcium phosphate, and only with hydroxide and carbonate in raw and purified bone meal. The exchange of fluorine with phosphate has not been observed in the heated samples of raw and purified bone meal. Thus, it can be said that the adsorption of fluorine takes place by exchange partly with hydroxide and carbonate and partly with phosphate of

these substances and the total quantity of fluorine removed is the sum of fluorine adsorbed through these two reactions. The nature of hydroxide, carbonate and phosphate that are exchanged with fluoride in the manner of Freundlich adsorption isotherm will be discussed separately in another communication.

(3) Rock phosphate, chlor-apatite and fluor-apatite, though akin to bone salt and calcium phosphate in the disposition of the principal molecular lattices, do not exhibit any fluorine-removing capacity.

(4) When fluorine as sodium fluoride is present in the liquid phase in concentrations that are usually encountered in the samples of drinking water in the areas of endemic fluorosis, i.e., 3-5 p.p.m., calcium carbonate does not show any fluorine removing capacity; but when present in much higher concentrations, calcium carbonate removes fluorine in the manner of Freundlich adsorption isotherm, except for the difference that whereas, in the case of bone salt and calcium phosphate, the quantity of fluorine adsorbed per gram of the material increases and the percentage adsorption decreases with the increasing concentration of fluorine in the liquid phase, in the case of calcium carbonate, both the quantity of fluorine adsorbed per gram of calcium carbonate and the percentage of fluorine removed increase with increasing concentration of fluorine.

(5) Calcium oxide and calcium sulphate remove fluorine from an aqueous solution of sodium fluoride by the mechanism of anion exchange wherein the solubility of the precipitated calcium fluoride is the limiting factor for the complete removal of fluorine.

Details of this work will shortly be published elsewhere.

The author wishes to thank Prof. K. V. Giri for his keen interest in the work.

Dept. of Biochemistry,

Ind. Inst. of Science, T. K. WADHWANI,  
Bangalore, July 4, 1951.

I. Gassmann, T., *Zeit. Physiol. Chem.*, 1928 **178**, 62.  
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#### NUTRITIVE VALUE OF THE SEEDS OF *AMARANTHUS PANICULATUS* LINN.

WHILE studying the nutritive value of certain little-known foodstuffs, the seed of *Amaranthus paniculatus* was taken up for investigation, as it came to our notice that the puffed seed is consumed in small amounts in various parts of the country.

Samples of the seed collected from different States showed an average percentage composition: Moisture 9-11, crude protein 14.5-16.0, carbohydrates 66.8 (starch by 'acid hydrolysis' 57.8 and 80% alcohol solubles 6.9), crude fibre 2.0 and ash 3.6. Of the ash constituents, calcium formed 6%, and phosphorus 18%. As it came to our notice subsequently, this composition is about the same as given by Sahasrabudhe,<sup>1</sup> who has classified the seed as an inferior millet. There does not appear to be any other published literature on the subject. The high protein and calcium content of the seed was suggestive of its value as an article of food and results presented in this note relate to this aspect.

The nutritive value of the protein of the raw seed at 10% level, as determined by the balance sheet method,<sup>2</sup> showed an average value of  $80.4 \pm 0.62$  for digestibility coefficient, and  $73.7 \pm 1.25$  for biological value. As determined by the rat-growth method,<sup>3</sup> the protein efficiency ratio of the raw seed (at 10% level) was comparable with that of casein. The puffed seed, however, gave a lower value, thereby suggesting an impairment in the quality of the protein on puffing. The average figures for the increase in body weight per gram of protein intake are: casein  $2.27 \pm 0.09$ , raw seed  $2.12 \pm 0.07$  and puffed seed  $1.90 \pm 0.06$ .

In experiments conducted over a period of 8 weeks, rats fed *ad libitum* with raw and puffed seeds in place of rice in the rice diet<sup>4</sup> recorded an average weekly gain in weight of 13.3 gm. and 10.0 gm. respectively, as against 3.3 gm. in the case of rice.

The experimental diets had the following percentage composition: Seed (raw or puffed) or polished rice 78.5, tur dal (*Cajanus indicus*) 5.0, common salt 0.3, non-leafy vegetables 8.2, leafy vegetables 2.1, skim milk powder 0.9, and crude groundnut oil 5.0. Thus, it would be seen that the rice diet contributed, on an average, 8.0% protein and 0.05% calcium on a moisture-free basis, while the corresponding values in the diets containing raw or puffed seeds were 15.0% and 0.20% respectively. It would appear, therefore, that the higher protein and calcium content of the seed as compared to polished rice is responsible for the enhanced growth rate of animals.

Capacity for reproduction and lactation of the animals fed on the seeds was also normal in contrast to those on the rice diet.

Studies on the supplementary value of the seeds at different levels to the rice and wheat diets, its effect on the second generation of rats, the vitamin content of the raw and puffed

seeds, and the amino acid make-up of the protein are in progress.

Our thanks are due to Dr. V. Subrahmanyan, Director of the Institute, for suggesting the problem and for his keen interest in the investigation.

Central Food Tech. Res.  
Institute,  
Mysore,  
October 1, 1951.

N. SUBRAMANIAN.  
M. SRINIVASAN.

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#### CIRCULAR PAPER CHROMATOGRAPHY FOR THE SEPARATION OF AMINO ACIDS

RUTTER<sup>1</sup> has described a technique using circular filter-paper discs, which possesses many advantages over other techniques and has indicated its application to the separation of dyes, inorganic substances and to the analysis of some biological materials like plant extracts. The following work was undertaken to determine how far this technique would permit a separation of amino acids in a mixture. The apparatus and technique adopted were generally those described by Rutter, with slight modifications, suggested by Rao and Beri.<sup>2</sup> A more elegant procedure would be to make a short longitudinal cut (about  $\frac{1}{2}$  cm. length) at the centre of the filter-paper and to insert a folded paper strip (0.5 cm.  $\times$  6 cm., folded at the centre). This method of providing a detachable 'tail' for irrigating the paper with the solvent, is found to be more convenient and uniform distribution of the amino acids along the respective zones is obtained.

Whatman No. 1 (15 cm. diameter) filter-paper was used. The chromatogram was developed using *n*-butyl alcohol-glacial acetic acid-water mixture (40:10:50) as the developing solvent, the time of development being about 1-1½ hours. The chromatogram after drying in air was dipped in a solution of ninhydrin in acetone<sup>3</sup> (0.25 gr. in 100 c.c. of 95% acetone) and then dried at 37°C. in an incubator for about 15-20 minutes.

Concentric circular zones develop on the paper indicating the presence of amino acids, the diameter of each varying with the type of amino acid used. The zones are clearly visible and well defined. Fig. 1 shows four distinct circular zones of the amino acids, glycine, alanine, leucine and valine separated from a mixture. The accompanying table shows the R,



FIG. 1.

Circular paper chromatogram of a mixture of Alanine, Glycine, Leucine and Valine.

A-alanine; G-glycine; L-leucine; V-valine.

#### $R_f$ Values

Alanine	..	0.44
Arginine (1)	..	0.32
Asparagine	..	0.31
Aspartic acid	..	0.37
Glutamic acid	..	0.44
Glycine	..	0.37
Histidine	..	0.50
Leucine	..	0.73
<i>Is</i> -leucine	..	0.70
<i>Nor</i> -leucine	..	0.75
Lysine	..	0.15
Methionine	..	0.92
Ornithine (2)	..	0.25
Phenylalanine	..	0.70-0.75
Proline	..	0.49
Serine	..	0.40
Threonine	..	0.44
Tryptophane	..	0.70
Tyrosine	..	0.58
Valine	..	0.62

(1) Applied as monohydrochloride

(2) Applied as hydrobromide

values obtained for the several amino acids using butanol-acetic acid-water as solvent.

In general the values are found to vary slightly from those reported by other workers by descending and ascending paper chromatographic techniques.

Amino acids which are not separated into distinct zones can be resolved by multiple development technique.<sup>4</sup> Distinct improvement in the separation of the amino acids is seen after each development. Fig. 2 illustrates the application

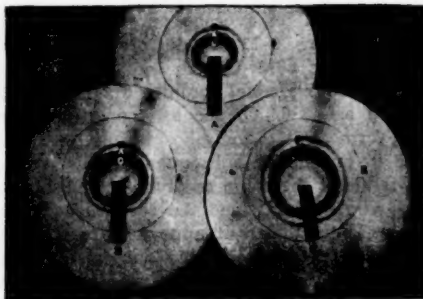


FIG. 2

Multiple development of the chromatogram of a mixture of Proline, Arginine and Ornithine.

A. First development

B. Second development

C. Third development

P. Proline

A. Arginine

O. Ornithine

S. Solvent boundary

of this technique to the separation of arginine and ornithine, which are not separated into two distinct zones by first development. By repeating the development, however, the two circular zones relating to the amino acids are separated from each other, after the third development.

Thus, amino acids can be separated by means of this technique and it is of particular interest that several chromatograms can be carried out at the same time and in short period. It is capable of wide application to the amino acid analysis of biological fluids.

Full details of the method will be published elsewhere.

Dept. of Biochemistry,  
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Bangalore,  
October 4, 1951.

K. V. GIRI.

1. Rutter, L., *Nature*, 1948, **161**, 435; *Analyst*, 1950, **75**, 37. 2. Rao, P. S. and Beri, R. M., *Proc. Ind. Acad. Sci.*, 1951, **33**, 368. 3. Tonnie, G. and Kolb, J. J., *Anal. Chem.*, 1951, **23**, 823. 4. Jeanes, A., Wise, C. S., and Dimler, R. J., *Ibid.*, 1951, **23**, 415.

#### STRUCTURE OF HUMULENE

HUMULENE on treatment with Aschan's reagent yields a crystalline, tricyclic, fully saturated alcohol, m.p. 116° which appears to be identical with the  $\alpha$ -caryophyllene alcohol of Asahina and Tsukamoto.<sup>1</sup> This reaction is of importance, since it transforms a monocyclic hydrocarbon into a tricyclic derivative. If the molecule of



humulene be represented by a system with more than 10 carbon atoms in a cycle, it is not difficult to visualise such a transformation which otherwise, normally is uncommon. Taking into account its close occurrence with  $\beta$ -caryophyllene, and the structure of the latter hydrocarbon as proposed by Sorm, Dolejs and Pliva<sup>2</sup> and modified by Dawson, Ramage and Wilson,<sup>3</sup> the formula (I) for humulene appears to be attractive.



This explains the reactions of the hydrocarbon known so far. The formation of laevulinic aldehyde<sup>4</sup> can be explained if the exo-cyclic double bond becomes endocyclic. If such a system can be transformed into a bicyclo-compound, we should normally expect a potential naphthalene or a potential azulene derivative. Humulene on treatment with *p*-toluene sulphonic acid gives a bicyclo-humulene which, on dehydrogenation over Pd-C at 325-335°, gives an azulene.

Though the present studies are far from complete, it has been thought desirable to place the results of the investigation on record in view of the publication of an advanced communication by Clemo and Harris<sup>5</sup> on this subject.

Controlled oxidation of a dihydrohumulene and further work is in progress to throw more light on the subject.

The humulene for this investigation was isolated from the essential oil of Wild Ginger<sup>6</sup> (*Zingiber zerumbet* Smith) and had b.p. 104°/3 mm.,  $n_D^{25}$ , 1.5005;  $d_4^{25}$ , 0.8900; and  $[\alpha]_D^{25}$  -0.9°.

Full details will be published elsewhere.

The author is thankful to the National Institute of Sciences of India for the award of the Senior Fellowship.

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#### ANTITUBERCULAR ACTIVITY OF CUCURBITA PEPO

THE following communication deals with the anti-tubercular activity of *Cucurbita pepo*, a vegetable widely recommended, for arresting hæmoptysis and controlling the disease process in pulmonary tuberculosis.<sup>1,2</sup>

*C. pepo*. Roxb. 700. *N. O. Cucurbitaceæ* (Syn. white melon, *Budi-gumbala*, *Kushmanda*) is cultivated in gardens throughout India. The fruit is used as a household vegetable. Extract from the ripe fruit is regarded as a diuretic, tonic and is used in painful micturition, calcareous affections and general urinary disorders, besides its specific use in tuberculosis.

The outer skin and the inner seeds having been removed, the fleshy part of a ripe, well-preserved fruit was minced with an equal quantity of water in a waring blender; the extract was concentrated to half its volume over a water-bath and strained through muslin. Further concentration was carried out under reduced pressure and finally dried over  $\text{CaCl}_2$  in a desiccator. The yield was 10% of the original weight. A brown sweet-smelling syrupy liquid of the consistency of treacle, of pH 6.8, was the product obtained.

"*In vitro*" tuberculostatic activity.—This was first determined in Youman's synthetic liquid media using  $D_{13}$  and  $H_{37}$   $R_e$  strains of *Myco. tuberculosis*, by methods already described.<sup>3</sup> The extract inhibits the growth of these virulent strains completely in a 1/10,000 dilution and retards more than 50% of the growth in a 1/100,000 dilution.

The tuberculostatic action was next tested by incorporating the various dilutions of the extracts in a rich nutrient solid media (Petrick's<sup>4</sup> media gave the best results in our studies), and seeding varying amounts of different strains of *Myco. tuberculosis*. Tests were made in duplicate, the results being noted at the end of 3 weeks. Table I summarises the results obtained against an inocula of 0.1 mg. of tubercle bacilli.

TABLE I  
Anti-Tubercular Activity of a Watery Extract of  
*C. pepo* in Petrick's media

Concentration of the extract	Strain of <i>Myco. tuberculosis</i>		
	$D_{13}$	$H_{37}R_e$	B.C.G.
1/100	—	—	—
1/1,000	—	—	+
1/10,000	+	2+	2+

— No growth; + to 2+ various grades of growth.

The growth of the fresh virulent strain  $D_{13}$  was partially inhibited at 1/10,000 dilution. Complete inhibition of both the virulent strains was obtained in 1/1,000 dilution while the action against the non-virulent B.C.G. was of a much lower order.

The general anti-bacterial activity of the extract against some non-acid-fast organisms was



determined by the standard turbidometric method, with the results shown in Table II.

TABLE II  
Bacteriostatic Activity of *C. pepo*

Organisms	Extract concentration		
	1/100	1/1000	0
<i>Staphylococcus aureus</i>	—	+	+
<i>Streptococcus pyogenes</i>	—	+	+
<i>Bact. coli</i>	±	+	+
<i>Bact. typhosum</i>	±	+	+

± slight growth.

While the extract retarded the growth of a virulent strain of *Myco. tuberculosis* in 1/10,000, the bacteriostatic action against the gram + and gram —ve bacteria tested above was very slight, indicating thereby that the extract exerted a specific action against the virulent acid-fast *Myco. tuberculosis*.

The extract, though crude in nature, is thus seen to possess tuberculostatic activity of a degree, which could possibly be therapeutically useful.

Details are being reported elsewhere. The identification of the active principles and the *in vivo* evaluation in experimental murine tuberculosis is under investigation.

Our thanks are due to Dr. K. P. Menon for his advice and guidance.

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Biochemistry Dept., P. R. J. GANCAHIARAM.  
Ind. Inst. of Science, N. N. DE.  
Bangalore,  
October 9, 1951.

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#### SPECIFIC AGGLUTININATING ACTIVITY FOR HUMAN RED BLOOD CORPUSCLES IN EXTRACTS OF *DOLICHOS* *BIFLORUS*

THE presence of hæmagglutinating substances in the seeds of certain plants has been known for a long time.<sup>3</sup> Renkonen,<sup>4</sup> Boyd and Reguera<sup>1</sup> and Boyd<sup>2</sup> have studied the agglutinating activity of many species of plants against human red blood corpuscles. Boyd and Reguera found that saline extracts of the seeds of certain beans, especially Lima beans, possessed A specificity, the most powerful being a variety of *Phaseolus limensis* var. *limenianus* which was active against A<sub>1</sub> and A<sub>2</sub> cells in titres of 243 and 27 respectively. These authors tested one variety of *Dolichos* (*Dolichos lablab*) and found

it to be active against human red corpuscles of groups A, B and O.

It is the purpose of this communication to record specific activity against human red blood corpuscles of group A (and AB) in saline extracts of the seeds of *Dolichos biflorus*. There was no activity against cells of groups B and O. The extracts were prepared by the mortar and pestle technique of Boyd and Reguera. Fresh extracts of one variety of these seeds (*Dolichos biflorus*—Belgaum 1-1-8) were found to agglutinate A<sub>1</sub> and A<sub>2</sub> cells in titres of 32, 768 and 16 respectively. The avidity was adequate for a blood typing reagent, powerful agglutination resulting with the undiluted extracts in 1 minute against A<sub>1</sub> cells, and in 4½ minutes against A<sub>2</sub> cells.

This extract agglutinated all of 86 samples of A<sub>1</sub> cells, 6 samples of A<sub>2</sub> cells, 25 samples of A<sub>1</sub>B cells and 2 samples of A<sub>2</sub>B cells. Activity against A<sub>2</sub>B cells was weak. No false positives or negatives were encountered. The extract was compared with a standard human anti-A serum of average potency. The macroscopic titres against the various sub-groups tested are shown below:—

Cells	Extract of <i>Dolichos biflorus</i> —Belgaum 1-1-8	Human anti-A serum
A <sub>1</sub>	32768	1024
A <sub>2</sub>	16	32
A <sub>1</sub> B	512	128
A <sub>2</sub> B	1	16

The activity was not lost if the extract was stored in the frozen state, or if freeze-dried and reconstituted. Storage at room temperature was unsatisfactory since, after about a month, the extract produced some hæmolysis of cells of groups of A, B and O. A similar phenomenon resulted after about two months in the case of the extract stored at 4° C.—6° C. This is not a serious objection to the use of these extracts, because they are so easy to prepare. If it is not possible to store the extracts in the frozen or dried state, they can be made up from the seeds whenever required. A 2% suspension of fresh cells should preferably be used for carrying out tests with these extracts. When older cell suspensions were used, the agglutination which resulted was weaker than with fresh suspensions.

Saline extracts of *Dolichos biflorus* (Belgaum 1-1-8) may therefore be used as a cheap and easily prepared anti-A blood grouping reagent. Sera of human and animal origin are much more expensive, require more complicated preparation, and seldom, in the case of human sera, have

such a high anti-A<sub>1</sub> titre. So far, no satisfactory plant anti-B reagent has been discovered, though the search for this continues.

The full results of an investigation into the haemagglutinating properties of extracts of Indian plants will be published later.

I am grateful to Dr. B. N. Uppal and Dr. L. S. S. Kumar, for provision of seeds and much valuable aid, to Mr. K. K. G. Pillai for technical assistance and to the Director-General, Armed Forces Medical Services, India, for permission to publish this note.

Blood Transfusion Dept., G. W. G. BIRD.  
Armed Forces Medical College,  
Poona 1,  
September 15, 1951.

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#### THE IDENTITY OF *SCIRPOPHAGA* SPECIES ASSOCIATED WITH SUGARCANE IN INDIA (LEPIDOPTERA: PYRALIDAE)

RECENTLY, Kapur<sup>1</sup> (1950), has fully revised the taxonomy of the group of Crambine moths associated with sugarcane in India, by actual comparison with type material in the British Museum (Natural History). In this note the systematic position of the so-called different species of schoenobiine moths attacking sugarcane in India, is discussed.

Hampson<sup>2</sup> (1896), recorded six species of *Scirpophaga* (Treitschke) from India. He distinguished the different species chiefly by the colour of the wings and of the anal tuft of hairs of the females. Fletcher and Ghosh<sup>3</sup> (1919), mentioned two species of *Scirpophaga* from Pusa (Bihar), viz., *S. xanthogastiella* Walk. (= *auriflua* Zell.) and *S. monostigma* Zell. Later, Fletcher<sup>4</sup> (1928), distinguished two species, i.e., *S. nivella* (= *xanthogastiella* Walk.) and *S. monostigma*, the latter differing from the former in the forewing having a black spot. Cherian and Subramaniam<sup>5</sup> (1938), state that both the spotted (*monostigma*) and the non-spotted (*nivella*) specimens from Coimbatore (South India) have been identified by Dr. Tams of the then Imperial Institute of Entomology, London, as *S. rhodoproctalis* Hampson.

Mr. M. C. Cherian informed us (in litt.) that the Director of Imperial Institute of Entomology, while forwarding the identification wrote to him thus: "The species of *S. auriflua* and

*S. rhodoproctalis* are distinct. The male genitalia will at once distinguish the specimens of that sex and the females may be recognised by the colour of the anal tuft which is yellow in *auriflua* and red or pinkish in *rhodoproctalis*. The identity of *S. monostigma* is still uncertain as Mr. Tams has not been able to trace the type and the description is not sufficient to enable the species to be determined with certainty. It is quite likely that it may prove to be a synonym of one of the two species mentioned above."

According to the letter quoted above, *S. auriflua* (*nivella*) is distinct from *S. rhodoproctalis* and the distinction in the female is based on the colour of the anal tuft and in the male by the structure of the genitalia. We have not been able to compare the structure of the genitalia of *rhodoproctalis* from Singapore with our specimens. It is, however, not known whether the terminalia of the two species have been comparatively studied by Tams. As regards the colour of the anal tuft in the female, this character does not seem to be constant and is found to vary even in the progeny of the individuals bred from a particular locality. The colour of the anal tuft in the females of *S. nivella* and *S. monostigma*, has been found to vary from yellowish brown to pinkish or even reddish.

We have before us in the National Pusa Collection a large number of specimens of *Scirpophaga* bred from different localities in India. A careful study of the immature and adult specimens from various localities shows that they all apparently belong to one species only. The habits and life-history are not only similar but the larval and pupal stages of the so-called different species bear identical morphological characters [Isaac and Rao,<sup>6</sup> (1941); Isaac and Venkatraman,<sup>7</sup> (1941)]. The original description of *Topeutis* (= *Scirpophaga*) *rhodoproctalis* has been based on a female collected from Singapore and described by Hampson<sup>8</sup> (1919), as follows: 'Head, thorax and abdomen silvery white, the anal tuft rose-pink; antennae blackish at sides; fore tibia on outer side, the fore and mid tarsi and the hind tarsi except basal joint fuscous. Wings silvery white, the forewings with small black spot at lower angle of cell. Hab. Singapore (Ridley) I type, exp. 36 mm.' The above description agrees generally with that of *S. monostigma* in the presence of the black spot at lower angle of cell.

Breeding experiments carried out by one of us (Venkatraman), at the Sugarcane Breeding Station, Coimbatore, proved beyond doubt that *S. nivella* and *S. monostigma* are one and the same species. The two species inter-breed freely. When a male of *monostigma* (spotted)

mated with a female of *nivella* (non-spotted) the resulting offspring were found to contain both the spotted and the non-spotted forms. Even amongst the spotted ones obtained as a result of the crossing there were gradations of sizes of spots on the wings.

Photomicrographs 1 and 2 show the male genitalia of *S. nivella* from Delhi and *S. monostigma* from Coimbatore, respectively. It may



Photomicrograph 1. Male genitalia of *Scirpophaga nivella* from Delhi. Ae. Aedeagus; Hp Harpes; Tg. Tegumen; Vm. Vinculum.

Photomicrograph 2. Male genitalia of *Scirpophaga monostigma* from Coimbatore. Lettering as above.

be seen that there appears to be no typical difference in the structure of the genital armature in the spotted and non-spotted forms. In the light of the above observations, it may be concluded that the species of *Scirpophaga* occurring in India are identical and that there is only one species, viz., *Scirpophaga nivella* Fabricius, which being the earliest name has precedence over others.

Division of Entomology, E. S. NARAYANAN.

I.A.R.I., New Delhi, T. V. VENKATRAMAN.  
June 29, 1951.

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#### A PTEROMALID HYPERPARASITE ON *STENOBRACON DEESAE* (CAM.)

*Stenobracon deesae* (Cam.) is a potential larval parasite of the sugarcane and maize borers. Recently, a pteromalid hyperparasite (Fig. 1)

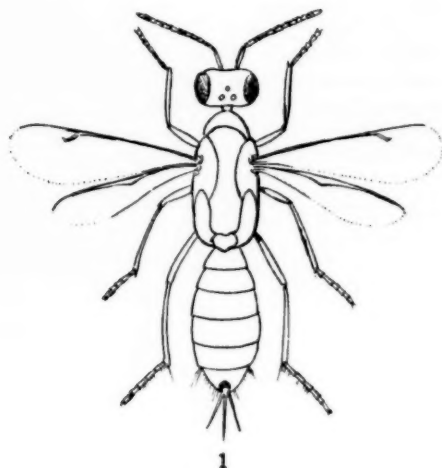


FIG. 1. Pteromalid female  $\times 16$ .

" 2. *Stenobracon* cocoon showing exit hole of hyperparasite.

" 3. " " cut open, to show pupal remains.

" 4. " " healthy showing exit hole of parasite.

Lettering, e. h. exit hole; s.p. *Stenobracon* pupal remains.

has been found to parasitise the pupae of *S. deesae* in Delhi. So far, there is no record of any hyperparasite attacking *Stenobracon*.

The pteromalid selects fairly advanced pupae of *S. deesae* for oviposition. Generally, only one hyperparasite is found to emerge from a single pupa. The female wasp starts laying eggs soon after emergence, if a host of suitable stage is provided. The female pierces the tough parasite cocoon by means of its long ovipositor and lays eggs inside the abdomen of the pupa. Fig. 2 shows the cocoon of *Stenobracon* containing the exit hole (e.h.) of the hyperparasite and Fig. 3 shows the same cut open to show the remains of the *Stenobracon* pupa on which the hyperparasite grub had fed (s.p.). Fig. 4 shows the healthy cocoon from which the *Stenobracon* parasite has emerged out. Healthy cocoons are whitish in colour, while those attacked by the hyperparasite are dark brownish in colour.

The authors feel that the discovery of a hyper-

parasite on *Stenobracon* will be a warning to other entomological workers in India, to examine their material more carefully before introduction and establishment of the parasite in the field.

Div. of Entomology,  
I.A.R.I., New Delhi,  
July 19, 1951.

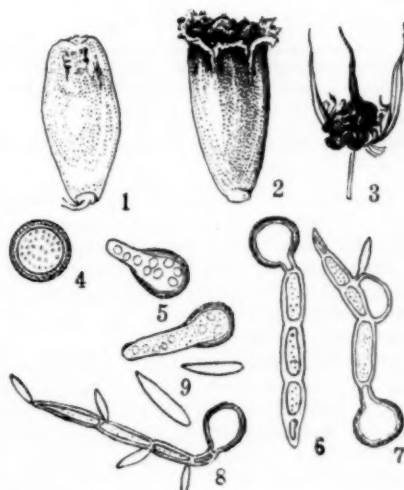
E. S. NARAYANAN.  
T. V. VENKATRAMAN.  
B. R. SUBBA RAO.

#### A NEW SMUT OF SUGARCANE

ON sugarcane, only culmicolous type of smut caused by *Ustilago scitaminea* Syd. and its two varieties (Mundkur, 1939), are known to occur. A few unusual infections of sugarcane smut reported by Chona (1943), affecting leaves, stem and inflorescence were also ascribed to *U. scitaminea*. But in June, 1950 the senior author, during his tour to Karnal, observed an ovaricolous smut on two sugarcane varieties, Co. 560 and Co. 561, in a collection of about 600 varieties growing at the sugarcane sub-station. Some of the affected plants were brought to Delhi and transplanted for further observations.

The smutted plants are stunted in growth, the internodes are shortened and there is profuse tillering as also the production of laterals by the sprouting of the normally dormant buds of the affected shoots giving them a bushy appearance. The affected plants come into flower much earlier in the season (May-June), and smutted panicles continue to appear for a long time. Almost all the panicles produced are smutted, rarely one or two may escape infection, and all the flowers are smutted suggesting the systemic nature of the smut.

The *sori* are developed in essential organs of the host. Both stamens and pistil are transformed but at times only the ovary may be transformed. The sorus when still enclosed in the glumes, is elliptic or barrel-shaped (Fig. 1) but tends to become conical later. The sorus is hypertrophied about  $1\frac{1}{2}$ -2 times the size of normal ovary and is enclosed in a whitish grey papery membrane, which is formed of fungal tissue. The sorus is usually 7-8 mm. long and 2-3 mm. broad but the size seems to be largely determined by environment. *Sori* greatly different in size have been observed at different times of the year. The soral membrane may burst before the sorus comes out of the glumes or soon after, thus exposing the blackish powdery spore mass for dissemination. The rupture usually takes place at the tip (Fig. 2) but eventually the entire membrane disintegrates. In the centre of each ruptured sorus, a rod-like structure, *Columella* (Fig. 3), shows itself up prominently and persists for a considerable time. The *columella* is hard, pointed at the tip



and thicker towards the base, straight or slightly curved, about 6-7 mm. in length though *columella* 12 mm. long have been occasionally met with. It is composed of the host tissue in the centre with a peripheral layer of fungal tissue.

Spores completely fill the space between the *columella* and the soral membrane and those nearer the *columella* are lighter in colour and smaller in size. They are roundish, Saccardo's Umber to light brownish olive in colour (Ridgway, 1912), and provided with epispore of uniform thickness having indistinct pittings (Fig. 4). Sometimes intermixed with the spores are hyaline roundish cells of the same size as the spores or somewhat smaller. The pseudoparenchymatous soral membrane consists of hyaline, roundish cells with very thick walls.

Germination of spores (Figs. 5 and 6), occurs readily in water and the spores start putting forth germ tubes in about 4 hours' time, the optimum temperature for germination being 25-26° C., the maximum 30-31° C. and the minimum 10-12° C. Normally the spore produces a 4-celled promycelium on which fusiform sporidia, both terminal and lateral (Fig. 8), are produced. Sometimes two cells of the promycelium may join together by buckle joint (Fig. 7). Ordinarily numerous sporidia are produced which bud out secondary sporidia. If, however, the temperature for germination is unfavourable, say 30° C., or above, spores germinate directly into a germ tube. The sporidia (Fig. 9) are hyaline, single-celled, fusiform and measure 10-15  $\mu$  (mostly 12-13  $\mu$ ) in length.

In India, three closely allied species of *Sphaelotheca* resembling the one under study have

	Range	Highest Frequency	Average
<i>Sphacelotheca schweinfurthiana</i> on <i>Saccharum munja</i>	7-10 × 6-10 μ	8-9 × 8-9 μ	8.3 × 7.8 μ
<i>Sphacelotheca schweinfurthiana</i> on <i>Imperata cylindrica</i>	7-11 × 6-11 μ	8-9 × 8-9 μ	8.6 × 8.2 μ
<i>Sphacelotheca sorghi</i> on <i>Sorghum vulgare</i>	5-9 × 5-9 μ	5-7 × 5-7 μ	6.9 × 6.2 μ
<i>Sphacelotheca cruenta</i> on <i>Sorghum halepense</i>	5-9 × 5-8 μ	7-6 × 7-8 μ	7.8 × 7.5 μ
<i>Sphacelotheca</i> sp. on <i>Saccharum officinarum</i> (Co. 560 and Co. 561)	5-9 × 5-8 μ	7-9 × 7-8 μ	7.9 × 7.6 μ

been recorded on Graminae. These are *Sphacelotheca schweinfurthiana* (Thum.) Sacc., *S. sorghi* (Link) Clint. and *S. cruenta* (Kuehn) Potter. Apparently all look alike. However, there are some minor differences between them. Their spore measurements (based on the study of 50 spores each), are as follows:

But for the spores of *Sphacelotheca sorghi* which are comparatively smaller, in the others there is hardly any difference of diagnostic value. In *Sphacelotheca schweinfurthiana* the sori tend to be tubular, slightly curved and pointed but they are ovate in *Sphacelotheca sorghi*. In *Sphacelotheca cruenta* and *Sphacelotheca* sp. on *Saccharum officinarum* (Co. 560 and Co. 561) they tend to be intermediate between the two in shape. Furthermore both these latter species are distinct from *Sphacelotheca schweinfurthiana* and *S. sorghi* in having indistinct pittings on the epispore. As *Sorghum halepense* happens to be one of the parents of Co. 560 and Co. 561, and this smut agrees in all respects with *Sphacelotheca cruenta* (Kuehn) Potter, the two smuts are considered identical. No *Sphacelotheca* sp. has so far been recorded on sugarcane.

Further studies on the cross-inoculation tests of these smuts are in progress.

Grateful thanks are due to Dr. R. S. Vasudeva, for helpful criticism and for providing the necessary facilities.

Div. of Mycology and

B. L. CHONA.

Plant Pathology,

R. L. MUNJAL.

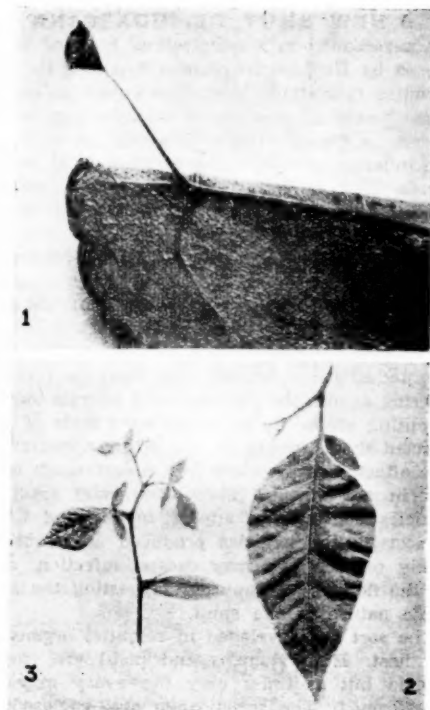
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New Delhi, July 6, 1951.

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#### SOME LEAF ABNORMALITIES OF *AEGLE MARMELOS* CORR.

The terminal leaflet of one of the leaves collected from an *Aegle Marmelos* (Rutaceae) tree growing in the departmental garden showed the formation of an ascidium (Photo 1). The cup-shaped ascidium measured 2 mm. across and had a stalk 7 mm. long and arising from the midrib on the lower side of the terminal pinna at a distance of 5 mm. from the



Explanation of Photographs.

1. Terminal leaflet showing the stalked ascidium arising from the midrib on the lower side of the pinna. × 3.  
2. A single leaf on a branch showing only two leaflets the third (basal) leaflet being suppressed. × 1.  
3. A small branch showing a few normal trifoliate leaves and one leaf where the two basal leaflets are suppressed and only the terminal leaflet remains. × 1/2.  
tip. Serial sections of the ascidium, its stalk and the part of the leaf on which it is borne, showed the following anatomical features. The single arc-shaped bundle of the leaf midrib is cut into three arcs by sclerenchymatous wedges. One of these arcs moves to the lower side, into the stalk, and splits up into a number of strands. These later on arrange themselves into a concentric bundle with plates of xylem, and traverse in this manner the greater part of the stalk of the ascidium. Just near the base of the ascidium the stalk becomes hollow in the



centre and the concentric bundle flattens out into a small arc as in the midrib of the leaf. This is the only prominent bundle seen in transverse sections of the ascidium. From this bundle arise a number of strands like the lateral veins from the leaf midrib and form a regular network in the ascidium. In all these bundles the xylem faces the interior of the ascidium. The mesophyll of the ascidium is differentiated into the spongy and palisade. The ascidium is lined by a layer of epidermis below which occurs the palisade parenchyma, 2-3 cells thick. A few stomata were also found interrupting this epidermis. Secretory cavities occur both in the leaf and in the ascidium but are not seen in the stalk.

The ascidium described above falls under the category known as *Notoascidium*.<sup>1</sup> Worsdell<sup>2</sup> mentions that such ascidia have been seen arising from the lower side of *Brassica oleracea* (Cabbage) leaves and has figured a specimen of the same species showing the ascidium arising from the upper surface.<sup>3</sup> Other examples quoted by him are *Hedera helix*, *Michaelia champaka*, and the well-known and quite common *Codiaeum variegatum*. Masters<sup>4</sup> has also figured a lettuce leaf showing an ascidium on the underside.

It appears as though the ascidium described in this note is of the nature of an enation—a stalked leaf with an abbreviated lamina (formed by the excavation of the stalk) which has folded itself inwards to form an epiascidium. The outer surface of the ascidium is evidently the morphological lower surface of a leaf. This is borne out by the fact that the xylem of the bundles and the palisade tissue both face the interior of the ascidium. This direction is quite opposite to the one in which the same tissues of the leaf face. This fact is quite in obedience to the 'law of laminar inversion, according to which opposed laminar surfaces are similarly constituted'.<sup>5</sup>

Other abnormalities noticed were the suppression of one (Photo 2) or both the basal leaflets (Photo 3), of the trifoliate leaf. Both these cases come under the category known as Simplification.<sup>6</sup> Penzig<sup>7</sup> quotes examples of *Aegle Marmelos* leaves where the terminal leaflet itself is modified into a small basal epiascidium. So far as could be made out no other leaves of the small tree in the departmental garden showed the ascidium figured in Photo 1, nor did any of the pinnae show the basal epiascidium quoted by Penzig. The occurrence of a *Notoascidium* and the other abnormalities referred to above have, so far as I am aware, not yet been recorded in *Aegle Mar-*

*melos*. I wish to express my thanks to Mr. K. P. Srivastav who very kindly cut the serial sections for me.

Department of Botany,  
University of Lucknow,  
September 6, 1951.

A. R. RAO.

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#### HALF INFERIOR OVARY IN A VARIETY OF KHARBOOZA, *CUCUMIS MELO* L.

THE character of inferior ovary is very much fixed in the family *Cucurbitaceae*, but in a recent survey of the eastern districts of Uttar Pradesh to collect different variants of kharbooza (*Cucumis melo*, L.) it was found that, in all the variants numbering 90, the ovary is never completely inferior as it is found in other species of the genus *Cucumis* or varieties of *C. melo* L. like kakri (var. *utilissimus*), phut (var. *Momordica*). In Kharbooza, as a rule, the calyx-cup always falls short of the developing ovary, and a small part of the ovary is always left exposed at the apical end. This exposed part appears as a cap on the rim of the calyx-cup and varies in size and form in different variants.

In the type under investigation the exposed part of the ovary is practically half out of the calyx-cup (Fig. 1).

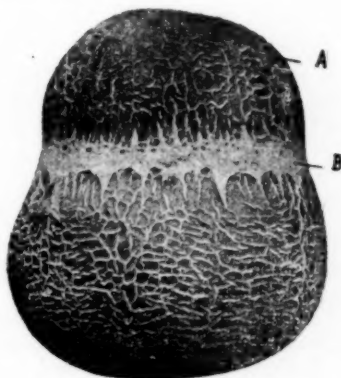


FIG. 1. A fruit of *Cucumis melo* L. (Kharbooza) showing half exposed ovary. A. Exposed ovary. B. Rim of the calyx-cup.

It is proposed to continue the work in other parts of the State.

Herbarium,  
The National Botanical Gardens,  
Lucknow, September 19, 1951.

K. N. KAUL.

# OBSERVATIONS ON THE VIABILITY OF FREEZE-DRIED RANIKHET (NEWCASTLE) DISEASE VACCINE

FOLLOWING the technique of Iyer and Dobson (1940), who first showed that virulent Newcastle disease virus (the identity of which with the Ranikhet disease virus has been fully established) could be attenuated by serial passages in embryonating eggs, Haddow and Idnani (1946), evolved a strain of attenuated Ranikhet disease virus which has proved most effective in affording protection against this highly fatal disease of fowls and since then, a vaccine prepared from this strain is being extensively used in India and many foreign countries. The immunity produced by such a vaccine has now been shown to last up to at least four years which is practically the normal span of life of a fowl (Seetharaman, 1951).

On account of its very fragile nature, this vaccine is liable to deteriorate rapidly under ordinary atmospheric conditions. Experiments were undertaken with a view to evolve a desiccated product with better keeping qualities so that the vaccine could be supplied in a potent form by post even to places far away from the place of its manufacture.

The first attempts in this direction were to dry the vaccine, which consists of live attenuated virus contained in the allantoamniotic fluid collected from the embryonating eggs used for the propagation of the virus, in 0.25 c.c. volume in 0.5 gm. glucose base. The powder thus obtained on test in fowls did not show any signs of deterioration as compared with the original wet vaccine. It was also found to be potent when tested after 5 days' storage at 37° C., after 15 days at 32° C. and after 90 days at room temperature (19–26° C.). But when despatched by post to different places in the plains in the month of October and received back for test, the vaccine proved potent after 5 days but not after 7 days of despatch; thus indicating that although some improvement had been effected in the keeping quality of the vaccine as a result of desiccation, it was not to the desired extent.

On the assumption that virus particles lodged in the intact cells would be less liable to the action of physical agents, like heat and light, it was decided to incorporate into the vaccine for drying, the chorioallantoic membrane from the infected eggs. This membrane was found to have in it the same concentration of virus as the allantoamniotic fluid. A suspension, prepared by grinding the membrane in double its quantity of allantoamniotic fluid was dried by cryochem process in small tubes in 0.25 c.c. quantities. On test, this powder was found to

retain its potency after 40 days' storage at 37° C. and after 21 days' storage at 42° C.—the maximum period of storage so far tested. Tubes containing this dried vaccine were despatched by post to Lucknow, Bombay and Madras and were received back after periods varying from 6 to 16 days. When tested in fowls, this vaccine was found to be potent even in a dilution of  $10^{-7}$ . The dilution of the wet vaccine used as a routine for vaccination of fowls being 1 c.c. of a  $10^{-3}$  dilution, the dry vaccine prepared as above when used in the same dilution of  $10^{-3}$  provided a fully potent product capable of easy despatch by post even to remote places.

Large scale field trials are being undertaken with this new product to compare its immunising properties with those of the original wet vaccine. The details of this work along with the results will be published in due course.

Ind. Vet. Res. Inst.,

Mukteswar-Kumaun, U.P.

May 22, 1951.

M. R. DHANDA.

C. SEETHARAMAN.

P. R. NILAKANTAN.

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**SPONTANEOUSLY-ORIGINATED  
HEXAPLOID AND TETRAPLOID  
PLANTS IN CAJANUS CAJAN MILL SP.**  
TEN unusual plants, having thicker and larger leaves and abnormal floral structures as compared to those of the diploid plants, were observed at Kanpur during 1950–51. Chromosomal counts from smear preparations of the anthers showed that one plant was hexaploid,  $N = 33$ , and nine plants were tetraploids,  $N = 22$ . The hexaploid plant was definitely smaller in height than the representative plants of the tetraploids or the diploids. The hexaploid plant did not set a single seed. Out of the tetraploid plants two set sufficient number of seeds, three set a few seeds only and the remaining four did not set any seed at all.

A probable cause of the origin of such a large number of polyploids may be the doubling of chromosome numbers in the diploids, giving rise to tetraploid plants, and in a triploid, which may have been present in the field, giving rise to hexaploid plant, by natural cold treatment of the standing crop by hail storm during the month of March in 1950.

The detailed chromosomal configurations and morphological descriptions of these plants will be published later.

Govt. Agricultural College,

Kanpur,

July 31, 1951.

G. N. PATHAK.

R. S. YADAVA.

## REVIEWS

**The Chemistry of Uranium, Part I. The Element, Its Binary and Related Compounds.** By J. J. Katz and E. Rabinowitch. McGraw-Hill, 1951. Pp. 610.

The book under review forms the fifth volume of Division VIII of the National Nuclear Energy Series, an important publication sponsored by the United States Atomic Energy Commission. This series publication, which when completed would run into several volumes, contains a comprehensive account of the scientific and technical achievements of the war-time projects for the development of atomic energy.

Very little was known about the chemistry of uranium before 1940. As a knowledge of the chemical properties of uranium and its compounds was required in the development of nuclear energy, a detailed programme of experimental research in uranium chemistry had to be undertaken even at the very inception of the Atomic Energy Project. These investigations led to a vast accumulation of new chemical information. After the war, the publication of the results of fundamental research in the field of uranium chemistry in the National Nuclear Energy Series was entrusted to Dr. Katz and Dr. Rabinowitch who were both employed in the Information Division of the Manhattan Project. The first part of this treatise on uranium chemistry has just been published and is being reviewed here. It deals with the element uranium—its occurrence, preparation and physical and chemical properties—and simple uranium compounds. It is the field described by the vague term, "Dry Uranium Chemistry".

The book is divided into 16 chapters, which have been grouped into four parts. Part I deals with the isotopic composition and the atomic properties of the element uranium and also with the occurrence and composition of uranium minerals. An account of the methods of extraction of uranium from ores and the preparation of the pure metals is given in Part II. The physical and chemical properties of uranium metal have also been described in detail in the same section. In this Part is included a brief survey of the mutual solubility of uranium and various metals and a description of some inter-metallic compounds of uranium. The next Part deals with the simple binary compounds of uranium such as hydrides, oxides, borides, carbides, silicides, sulphides, etc. Their methods of pre-

paration, physical and chemical properties and uses have been described. Part IV is devoted to the very important group of binary compounds of uranium, namely, fluorides, chlorides, bromides and iodides. The properties of uranium hexafluoride which is the only known stable gaseous compound of uranium have been described in some detail.

The book can be described as a review of the available "declassified" information on the subject. The review is neither critical nor complete, as a part of the information on basic uranium chemistry is still kept restricted. The references to the original papers and to project literature have been very exhaustive. The book is of very great interest not only to inorganic chemists but also to atomic physicists.

R. S. K.

**The Interpretation of X-Ray Diffraction Photographs.** By N. F. M. Henry, H. Lipson and W. A. Wooster. (Macmillan & Co., London). 1951. Pp. 258. Price 42 sh.

This book satisfies a long-felt need for a comprehensive treatise on the practice of X-ray crystallography. There are, of course, a number of works dealing with the principles of the subject; but with the exception of Buerger's book, none of them are really helpful to the practical worker. Buerger has, however, confined himself to moving film methods and to the precision determination of lattice spacings, to the exclusion of other methods. On the other hand, the book under review covers practically the whole gamut of techniques which are of general use at present.

The first three chapters deal briefly with crystal symmetry, the properties of X-rays and the derivation of Bragg's Law and its interpretation in terms of the reciprocal lattice. The remaining fourteen chapters are mainly devoted to the interpretation of various types of photographs. These deal not only with the determination of the unit cell and the methods of indexing the spots, but also with other techniques such as the study of orientation in single crystals, of preferred orientation and grain size in polycrystalline aggregates, measurement of intensities and the identification of materials by powder photographs.

The book abounds in charts and photographs; these are reproduced to scale and examples have

been set for being worked out. A large number of tables are included, mainly as appendices, so that it is unnecessary to refer elsewhere for any data. A novel feature of the book is the method of numbering figures and tables by means of the pages in which they occur, and this greatly facilitates cross-references. So also, the inclusion of references along with the author index is to be commended. But the numbering of sections is not so convenient; the use of three numbers, e.g., 10, 1, 6, may, no doubt, strike a familiar chord to the crystallographer accustomed to his *hkl*, but one is likely to forget the number of the sub-section by the time he has looked up the chapter and the section.

In spite of the excellence of the treatment, in so far as the subjects treated in the book are concerned, the reviewer cannot subscribe to the view that it is a suitable text book for a beginner to learn X-ray crystallography. A good amount of previous knowledge of the subject is assumed and it is surprising to find the topic of structure factors discussed for the first time only in Chapter 15. The result is that many statements in the earlier chapters, e.g., "The study of systematically absent reflections is essential in the determination of space-groups..." in 7, 5, 2 and "But it is clear that orders of 0001 occur only when  $l = 3n$ , and therefore a screw-triad axis must be present" in 10, 3, 3 are not readily appreciated. This is particularly so, because a discussion of what are space-groups or screw-triad axes is considered to be beyond the scope of the book. The reviewer hopes a brief account of space-group theory would be included in a later edition, so as to make the book more self-contained.

The printing and get-up are excellent, and there appears to be not a single typographical error in the whole book. The index, however, is not complete, for instance, it does not contain the reference to Lonsdale, 1947 b, found in pages 42 and 205 and "space-group" occurs in many more pages than are mentioned in the index, e.g., 100, 145, 149, 160, etc.

The book will prove to be an indispensable companion to the "general practitioner" of X-ray crystallography.

G. N. RAMACHANDRAN.

**The Yeast Cell—Its Genetics and Cytology.** By Carl C. Lindegren. (Educational Publishers, Inc., Saint Louis), 1949. Pp. xviii+365.

The author, who is a distinguished cytologist, has presented in this volume, a review of eight years' of his own pioneering studies on the genetical and cytological aspects of the Yeast

Cell. These researches have shown that the Yeast Cell is a conventional cell with chromosomes, nucleolus, heterochromatin, centrosomes and mitochondria. For the first time, the chromosome maps of the Yeast Cell have been constructed and new concepts of the nature of hereditary apparatus, developed. The author's views may be considered revolutionary and unorthodox from many points of view but he has raised many interesting points which would stimulate helpful controversy and lead to further progress in this difficult subject.

The work described in this volume has been made possible by the continued and generous support extended to the author by the famous Brewers, Anheuser-Buch Inc. The enlightened interest shown by this firm is in line with the tradition of breweries in Europe, like the Carlsberg Brewery, who have taken a keen interest in the promotion of investigations in pure sciences.

**Modern Plastics.** Second Edition. Revised. By Harry Barron. (Chapman & Hall, Ltd., London), 1949. Pp. xx+779. Price 50 sh. net.

The first edition of this extremely useful, highly informative and admirably introductive volume on modern plastics was written in 1944, on the eve of the Allied invasion of Europe, an event which highlighted in a vivid and spectacular manner, the vital and varied role played by plastics in the production of munitions. During the subsequent post-war years, the peace-time applications of plastics have been no less varied and extensive; the post-war period has witnessed not only the large-scale manufacture of plastics formerly considered as laboratory curiosities, but also a phenomenal expansion of the applications of plastics. To-day plastics which has attained the status of a major industry, is able to offer to the engineer and the technologist, a bewildering variety of materials of construction, possessing attractive and versatile properties. The introduction of plastics as a material of construction into industry, has served to conserve the strategically important metallurgical resources.

The author has taken advantage of the second edition to revise the subject and bring it up-to-date. The volume is divided into six parts and consists of 32 chapters dealing with the various aspects of the plastics industry—raw materials, manufacturing processes, plastic technology, machinery and equipment, applications of plastics, chemical and physical testing of the products.



The volume constitutes an excellent introduction to the subject of plastics, furnishing information and data of practical value and technological interest.

**Fats and Oils; Soyabean and Soyabean Products, Vol. II.** Edited by Klare S. Markley. (Interscience Publishers, Inc., New York), 1951. Pp. xvii+541-1145 and Figs. 83. Price \$ 11.00.

This, the second volume of the series on Fats and Oils, dealing with soyabean, may be considered a supplement to the first volume. Other equally important aspects of soyabean and its products have been dealt with in this volume.

Solvent extractions of oil is fast replacing the other expeller processes. But as originally adopted, solvent extraction led to serious fire hazards and application of modern methods has overcome the initial difficulties. Solvent extraction has now been developed to a high degree of perfection.

Soya lecithin, which is a by-product in solvent extraction, plays a very important role in many commercial and food industries. It is interesting to note that soya lecithin acts better than lecithin from other sources. The other important qualities of soya lecithin have been discussed from the standpoint of its utility for practical application.

The chapter on nutritional value of soyabean and soyabean products gives a comprehensive treatment of the value of fat in nutrition and how this fat could largely be met from soyabeans. In fact, the development of soyabean in U.S.A. to this extent is mainly based on its fat content.

These two volumes supply a long felt need in putting together work done in various laboratories on the different aspects of soyabean.

The book bears good illustrations of the various equipment used in soyabean processing industry. The get-up is as usual excellent, and the book is bound to benefit the research worker greatly.

S. S. D.

**Advances in Carbohydrate Chemistry, Vol. V.** Edited by C. S. Hudson and S. M. Cantor. (Academic Press Inc., New York), 1950. Pp. xi+322. Price \$ 6.80.

This addition to the earlier volumes of the series has a new pair of editors but the editorial policy has been the same, namely, to have "individual contributors furnish critical, integrating reviews rather than mere literature surveys" in

the broad field of carbohydrate chemistry. The present report results from the efforts of fourteen contributors to ten reviews. These represent such a wealth of material of interest to the specialists as well as to the general chemist that a brief review could only serve by indicating the range of subjects covered. These include: Applications in the carbohydrate field of reductive desulfurization by Raney nickel (H. G. Fletcher and N. K. Richtmyer), Enzymic synthesis of sucrose and other disaccharides (W. Z. Hassid and M. Doudoroff), Enzyme specificity in the domain of carbohydrates (A. Gottschalk), Pectic enzymes (Z. I. Kertesz and R. J. McColloch), Crystallinity of the Celluloses (R. F. Nickerson), Commercial Production of Crystalline Dextrose (G. R. Dean and J. B. Gottfried), The Methyl Ethers of D-Glucose (E. J. Bourne and S. Peat), Anhydrides of the Pentitols and Hexitols (L. F. Wiggins), Action of Certain Alpha Amylases (M. L. Caldwell and M. Adams), and Xylan (R. L. Whistler).

The various chapters have been presented with remarkable clarity and conciseness and should save several hours of literature search to those engaged in related fields of work.

A. SREENIVASAN.

**Industrial Oil and Fat Products.** By A. E. Bailey. Second Edition. (Interscience Publishers, New York), 1951. Pp. vi+967. Price \$ 15.

The 1951 edition is in many ways a new and a thoroughly revised book with 217 additional pages of text and 53 more illustrations. The get-up and printing is of the same high standard as other books by Interscience Publishers.

The chapter on the reactions of fats and fatty acids has been brought up-to-date with fuller details, rancidity now occupies more than three times its former space, and information has been supplied regarding the now important spectral characteristics of oils. Amongst the new items mention must be made of data on hydrogenated shortenings, a review of the industrial applications of surface active agents and sections on the newer synthetic drying oils, co-polymerising materials and manufacturing operations in the varnish industry.

The bulk of the volume, however, is devoted to the technology of oil and fat industries in which the author describes the recent advances in industrial research on unit processes like solvent extraction, refining, bleaching, hydrogenation and deodorisation. To workers in India especially, this book will be of inestimable value.

S. A. SALETOR.



## Books Received

- The Plant Glycosides.* By R. J. McIlroy. (M/s. Edward Arnold & Co.), 1951. Pp. 138. Price 18 sh.
- Parasitic Animals.* By Geoffrey Lapage. (M/s. Cambridge University Press), 1951. Pp. xxi+351. Price 21 sh. net.
- ABC of Agronomy.* By R. K. Misra. (Published by K. L. Misra), 1951. Pp. 121. Price not given.
- The Parasites of Domestic Animals.* By Thomas W. M. Cameron. (M/s. Macmillan & Co.), 1951. Pp. xvi+420. Price 38 sh. net.
- Hydroponics.* By J. Sholto Douglas. (Oxford University Press), 1951. Pp. xii+147. Price Rs. 6.
- Studies on the Natural Fats, Vol. II, Part IV.* By A. R. S. Kartha. 1951. Pp. 111. Price Rs. 2.
- The Chemistry and Technology of Food and Food Products, Vol. II.* By Morris B. Jacobs. (Interscience Publishers), 1951. Pp. xxvi+839-1769. Price \$ 15.00.
- Biochemistry and Physiology of Protozoa, Vol. I.* Edited by Andre Lwoff. (M/s. Academic Press), 1951. Pp. x+434. Price \$ 8.80.
- Styrene—Monomers.* By A. L. Ward, W. J. Roberts, E. R. Blout and H. Mark. (M/s. Interscience Publishers, Inc.), 1951. Pp. 126. Price \$ 3.50.
- Survey of Modern Electronics.* By Pant G. Andras. (Asia Publishing House), 1951. Pp. x+522. Price \$ 5.75.
- Theory and Design of Valve Oscillators, Vol. VII.* By H. A. Thomas. (M/s. Chapman & Hall), 1951. Pp. xv+317. Price 36 sh.
- The Intelligent Use of the Microscope, Second Edition.* By C. N. Olliver. (M/s. Chapman & Hall), 1951. Pp. xii+192. Price 15 sh.
- Atlas of Frambæsta.* By K. R. Hill, R. Kodijat and M. Sardadi. (World Health Organisation), 1951. Pp. 18. Price 5 sh.
- Carburation, Vol. I, 3rd Edition.* By Charles H. Fisher. (M/s. Chapman & Hall), 1951. Pp. xv+356. Price 36 sh.
- Patented Inventions of the C.S.I.R., 1951.* C.S.I.R., New Delhi. Pp. 556. Price Rs. 15.
- Scientific Survey of Eastern Scotland.* (M/s. Macmillan & Co.), 1951. Pp. 207 + a map. Price 25 sh. net.
- The Neglect of Science—Essays Addressed to Laymen.* By F. E. Simon. (Basil Blackwell), 1951. Pp. v+138. Price 8 sh. 6 d.

## INTERNATIONAL CHEMICAL CONCLAVE—1951

THE International Chemical Conclave was held in New York from the 3rd to 13th September, 1951. There were nearly 18,000 delegates representing over sixty nationalities. However, there were no representatives from the countries of Eastern Europe under Communist control.

The first five days of the conference were devoted to the 75th Anniversary of the American Chemical Society when the Priestly Medal was presented to Dr. E. J. Crane. During the session, many technical papers were presented.

The rest of the Conclave was devoted to the 12th International Congress of Pure and Applied Chemistry. Many sectional meetings were held during which a large number of technical papers was presented. The most outstanding paper of the Conclave was that submitted by Prof. Woodward of the Harvard University in which he described the synthesis of many of the important steroids including cholesterol, etiocholanolic acid and cortisone in their naturally occurring forms.

One special feature of the Conclave was the section on chemical education. Chemists as a whole, and specially in America, seem to be very much interested in evolving and improving suitable methods for teaching chemistry to students of various educational levels. In Orga-

nic Chemistry, for example, considerable emphasis is laid on the electronic interpretations of organic reactions. Physicochemical methods like spectroscopy are being extensively used for routine operations. Instrumental methods of analysis are replacing the usual chemical methods in many analytical procedures.

One novel feature of the Conclave was the congregation of younger chemists below forty years of age from various countries under the Younger Chemists' International Project. There were 261 participants from forty-eight nationalities, of whom eleven were from India. The necessary finance was provided for the Marshall Aid countries by the E.C.A. and the non-Marshall Aid countries by the Ford Foundation.

After the Conclave, the participants were divided into groups according to their interest and taken in conducted tours for three weeks in different parts of the States. During the tour, they had the opportunity to visit many institutions including Universities, Research Institutions, Government Laboratories and Industrial concerns.

Each participant in the Younger Chemists' International Project was also presented with \$100 worth of technical books by the American Chemical Societies.

S. C. B.

## SCIENCE NOTES AND NEWS

### International Pharmacopoeia

WHO is preparing an International Pharmacopoeia that will cover the most important medicines used throughout the world. When completed, the manual will consist of three volumes covering several hundred drugs. The first volume, already published, includes pain killers, sleeping pills, antimalarial drugs, sulfa drugs and other compounds for fighting infection, and the most important vitamins. It is expected that antibiotics and hormones will be covered in the later volumes.

### Symposium in Chemistry

It is proposed to hold a symposium on *Chemistry of Hydrous Oxides* at the next Annual Session of the National Academy of Sciences, India, to be held in January, 1952. Dr. S. Ghosh, Reader in Chemistry, University of Allahabad, is expected to be the Chairman. Intending contributors are requested to send their papers accompanied by short abstracts by Air Mail immediately.

### Award of Research Degree

On the recommendation of a Board of Examiners consisting of Prof. Kathleen Lonsdale, Dr. W. A. Wooster and Dr. R. Furth, the thesis entitled "Crystal Elasticity (Ultrasonic and other Methods)" by Mr. R. V. G. Sundara Rao, M.Sc., has been declared qualified for the degree of Doctor of Science in Physics of the Andhra University.

On the recommendation of a Board of Examiners consisting of Prof. Sir John Simonsen, Prof. R. P. Linstead and Prof. Sir Ian Heilbron, the thesis entitled, "Synthetic Experiments in Trihydroxy Flavones and Study of Some Flower Pigments" by Mr. N. Viswanandham, M.Sc., has been declared qualified for the degree of Doctor of Science in Chemistry of the Andhra University.

### ISI—Fourth Annual Report

An important feature of the year's achievement which the Report records in detail was the growing recognition accorded to Indian standards by industry and Government Departments,

such as the Directorate-General of Industries and Supplies, the Railway Board, Directorate of Technical Development, Ministry of Defence and the Indian Posts and Telegraphs Department, which either adopted them in place of their older specifications or modified their purchase specifications by suitable reference to them. In the matter of laboratory facilities for tests, the Institution continued to receive active co-operation and assistance from all quarters in the country, and particularly from the laboratories of the Council of Scientific and Industrial Research, the Forest Research Institute, Dehra Dun, the Technical Development Establishment Laboratory (Stores), Kanpur, and the Government Test House, Alipore.

New subjects accepted for standardisation include transformers, chokes and wires used in radio industry, non-magnetic non-ferrous metals, wood poles, cast iron pipes, copper and brass tubes, wood screws, textile machinery, handloom cloth, sesame oil, groundnut oil, oil of peppermint, sodium stannate, potassium metabisulphite and phenyl.

In the international sphere the ISI is a member of the Council of the International Organisation for Standardisation (ISO), and the Director, Indian Standards Institution, is the Vice-President of the ISO.

### Geological Mining and Metallurgical Society of India

The Twenty-Seventh Annual General Meeting of the Geological, Mining and Metallurgical Society of India was held in Calcutta, on 14th September, 1951. In his Presidential Address to the Society, Dr. West drew attention to India's recent work on the development of mineral resources of the Damodar Valley, and pointed out that progress so far achieved in this direction was largely based on the fundamental geological work carried out in the past. He, therefore, laid great stress on this type of fundamental geological work which must be carried out alongside work of more important practical significance.

Mr. B. P. Agarwalla, at present Vice-President of the Society, was elected President, and Professors N. N. Chatterjee and N. L. Sharma were elected Joint Honorary Secretaries of the Society for 1951-52.

**Solar Eclipse Expeditions**

Plans are being made for at least six expeditions which will make use of a total eclipse of the sun on February 25, next year, and a report on weather prospects has been prepared by a Commission of the International Astronomical Union.

The duration of totality will be 3.0 minutes, the belt of totality stretching from Equatorial Africa to the U.S.S.R. with the Nile Valley near Khartoum as the most favoured area.

**International Industries Fair**

The Bombay International Industries Fair will be held in December under the patronage of the Indian Government and under the auspices of the Engineering Association of India.

**The Fourth Indian Pharmaceutical Congress**

Arrangements are being made for the Fourth Session of the Indian Pharmaceutical Congress to meet in Jaipur during the end of December, 1951. The programme will include science session for the reading and discussion of research papers under five sections:

Pharmacy, Pharmacognosy, Pharmacology, Ayurvedic Medicines and Pharmaceutical Chemistry. A symposium on "Pharmaceutical Education" will be the special feature of this session.

**Photosynthesis in the Laboratory**

The process by which the plant uses solar energy to convert water and carbon dioxide into carbohydrates is believed to consist of two stages: photolysis of water and reductive fixation of carbon dioxide. The second stage is presumed to be catalysed by enzymes and a trace of manganese. A significant portion of this process of photosynthesis has been reproduced in the test tube, according to a report on work by Prof. D. I. Armour of the University of California. Pyruvic acid was converted to malic acid and oxygen was evolved, exactly as occurs in plants. The catalytic role of manganese in the reaction confirms previous theories of its importance as a trace element in the soils. The achievement may be a long step towards a scientific advance that would be fully as important as the achievement of nuclear fission.

**Inter-Commonwealth Post-Graduate Scholarships in Science**

The above-mentioned publication, compiled by B.C.S.O. and published by H.M. Stationary Office,

is a comprehensive list of post-graduate scholarships available for scientific study within the Commonwealth. The main object of the list is to encourage the movement of scientists within the Commonwealth, and only those awards open to members of at least one Commonwealth country or colony other than the awarding one have been included. The price of the publication is 5 sh. and copies are available at all branches of H.M. Stationary Office.

**Penicillin Manufacture in India**

The Draft Agreement between the Government of India on the one hand, and WHO and UNICEF on the other, for the manufacture of penicillin in India, has been finalised. It is proposed that the penicillin factory should be located in the Poona District.

The factory will be entirely owned and controlled by the Government of India, and UNICEF will supply all the imported equipment, estimated at 850,000 dollars.

Other clauses of the agreement are that WHO will provide technical assistance and also arrange for the training of Indian personnel at an approximate cost of 350,000 dollars. WHO will award Fellowships for advanced training in connection with the operation of the plant. Production is likely to start in December, 1953, while full production is likely to be reached about a year later.

**Dr. B. Mukerji**

Dr. B. Mukerji, Director, Central Drug Research Institute, has been elected a Member of the Scientific Research Society of America. He has been invited as an expert to serve on the Advisory Panel of the International Pharmacopoeia.

**International Technical Cooperation**

Under the various schemes of technical assistance from foreign countries, India has so far obtained 32 experts and trainee facilities for 247 persons. The experts and the facilities have been made available to India under (a) the point-four agreement with the United States of America, (b) the Technical Co-operation Scheme of the Colombo Plan, and (c) by the specialised agencies of the United Nations. In fulfilment of her obligation as a member country of the Colombo Plan, India has also sent some of her own experts to foreign countries. Offers of training facilities have been made to Ceylon, Nepal and Pakistan.